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PROCEEDINGS

OF THE

AMERICAN SOCIETY OF MICROSCOPISTS.

EIGHTH ANNUAL MEETING.

ANNUAL ADDRESS OF THE PRESIDENT:

THE UNCONSCIOUS INFLUENCE OF SCIENCE STUDIES.

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In selecting a theme, proper for presentation upon an occasion like this, I have experienced no small difficulty. The Presidents who have preceded me have well-nigh exhausted all that could be said upon the history and applications of the microscope, and I labor under an especial disadvantage in appearing next after the able statesman and soldier whose counsel and wisdom contributed so materially to the success of the meeting at Rochester last year. Indeed, I must here be allowed to say, that had I been present at the close of that meeting I should, peremptorily, have declined to accept the high honor conferred upon me, and would have urged the claims of others of our members who have contributed far more than myself to make our Society thus far a success.

In the great field of physical science, especially that branch of it which demands the most of my time during the year, astronomy, the use of the microscope comes to me as a recreation, fascinating and every way pleasant, but yet not, as to the biologist, the all important instrument, without which not the first step in advance can be made. In this great and all important, I might almost say, the most of all important, science, we have many earnest and genuine workers, the results of whose labors cannot yet be estimated; and it would have been proper recognition of the value of the microscope in this field, if you had selected some one more familiar than myself with such studies, to have presented to you a *resumé* of what has been accomplished during the past year, and in this to have found an earnest of what we may hope for during the coming one.

And all the more I regret it now, for as I have been writing this address, far from home, there comes to me the sad intelligence of the death of one of our most honored associates, one who was already well known as a biologist, and one who, by his untiring efforts and zeal in microscopical science, made our meeting at Elmira three years ago such a brilliant success. He has gone from us in the prime of manhood, a victim of a most dreaded disease, the advent of which, and the certainty of a painful end, must have been known to him as a microscopist and skillful physician, long before the fatal termination. None who have ever known him will forget Thad S. Up de Graff. By you and by me will his memory be cherished, as the memory of one of Nature's noblemen, whereof he

> "Was a noble type,
> Appearing ere the times were ripe,
> That friend of mine who lives in God."

And now, as I am not willing to embarrass the movements of the Society by refusing to perform any duty that may be imposed upon me, and within my ability, with much diffidence and relying on your kind forbearance, I stand here this evening as your President, to deliver the Annual Address.

I have said that I have experienced considerable difficulty in the selection of a topic, which, while it might, at least so far as I could make it so, interest a popular audience, yet should not be foreign to the purpose for which our Association was formed. Manifestly, anything about the history of the microscope, the principles involved in its construction, or any sketches of those noble men who have devoted their lives to perfecting our instrument, are themes now closed, and something of a more general character seems to be demanded.

I have thought that, speaking at the annual meeting of a society organized to give a more efficient direction to forces which are contributing so largely to the welfare and growth of a nation, forces which have been, though the outside world was unconscious of it, effecting great changes in all departments of human investigation, and modifying so largely old opinions and habits, I might, in calling attention to the "silent conquests made by sowing the seeds of knowledge," not only contribute my small portion to further the aims of our Association, but might possibly, at the same time, give a new direction to the thoughts of some who have had little leisure or opportunity, hitherto, to study the relation between science and that social development upon which the happiness and well-being of a community is dependent. If I had but the skill to do this, corresponding at all with my ardent wishes, I am quite certain that, in meetings like the present, you would recognize great opportunities for doing good; we have laid aside for a little time our daily cares and toils, and we meet to consider, and to share with all the force of fresh impressions in the criticism and discussions of, the new advancements made in microscopical science during the past year; and, "where each receives some good from another, everybody gains, and mutual respect and kindness is increased."

While, in a general way, then, I take for my theme, the unconscious influence of natural science studies in the development of society, I must subordinate it, as far as practicable, to that particular branch of science which just now claims our attention, for, otherwise, the subject would be too vast, as it confessedly is too important, to be reviewed in a brief hour. I shall be able to say very little as to the unconscious influence of natural science studies in the development of mind, though that, indeed, is by no means the least important part of our subject; but, just now, as more practical and readily appreciated, it will be better to remind ourselves of the improvements in all that concerns our material comfort in the few decades past, improvements that have originated in the study of natural science.

And here, at the outset, I would not be understood as urging the claims of natural science, to the neglect of those other means of intellectual culture which characterize our present system of education; though, even here, just grounds for criticism might be found, especially in reference to the question, as to what a State may or may not teach in "matters belonging to the domain of conscience." Happily, I am not called upon to discuss this, in inviting your attention to the *unconscious* influence exercised by studies of nature, rather than to any conscious benefits immediately derived, though often the latter may be apparent enough.

When we survey the present condition of society, and attempt to analyse the problems of social relations and intercourse, which have become the topics of so many discussions and have called for so many expressions of difference of opinion, we are apt to lose sight of the more hidden and quiet forces, which, though unrecognized, are nevertheless controlling with irresistible power the movements of the age, and, in spite of the prejudice, the ignorance, the sordid motives, of temporary leaders, sometimes in the highest stations, are bringing good out of evil; and, as the round world itself, in obedience to laws unrecognised by the busy crowd, moves surely and truly on its axis and in its orbit, regardless of the cyclones and storms which, for the moment for us, appear to have the whole mastery of our being, so under influence of these, which are acting as the controlling and directing forces of political and social life, we are safely guided, and know that our hopes of ultimate success have a foundation, true as was the word pronounced when the Creator looked upon the world, with all its sky, its water and its land teeming with life, and behold "it was very good"; yes, and nothing but good can come from the study of this perfected nature, when properly conducted.

There was a time when it was not so conducted, but in a far different manner and this by very intellectual men; a time "when experimental science had no existence, and, indeed, was not believed to have sufficient power to compass nature." To-day, the speculative schemes of the ancient philosophers have vanished before the study of facts, and the world of reality is emerging from the "strange land of cosmological, geognostical, and imaginative dreams," a new creation has succeeded their destruction, and "melodious birth-songs are coming from the fires of the burning phoenix." And yet we have not parted entirely with the ideal world; happily, we enjoy it, in our studies of nature, untrammeled and untroubled by metaphysical conceptions. We care not to bother ourselves to show by intellectual processes, which probably never can be done, that "cause and effect is but the order of nature"; we feel and acknowledge, as every true student of nature must, the underlying regulative power; the facts may be discontinuous, like those of geology, for example, and sharply marked, draw the line wherever we will, but, as the geologist ideally constructs a progressive world, and as he knows that, on the whole, it is ever from a worse to the better, which is all that evolution can do, so we, microscopists, of all science students, confessing that our senses are far from revealing to us all the realities of nature, do not trouble ourselves with relation of cause and effect in social problems, but leave the leaven we may find, small as it is, in the bushel of meal, quite sure that, in time, the whole will be leavened.

Every branch of human knowledge, every department of human industry, now is feeling the influence of science studies, and slowly, but none the less strongly because unconscious of it, society is being moulded in conformity to its teachings, and developing, with constantly increasing noble and excellent results. "The old world has passed away, the age of the Hero, of the strong leader, is gone. The People have arrived and sit in judgment on who would rule or lead them,—Science has arrived and everything is upon trial." Theology, law, medicine, agriculture, commerce, what may we not include in the list, have, one and all, within the memory of some of us here, undergone wonderful change. The enlargement of corporeal vision, the greater comforts of material existence, the practical annihilation of time and space, the multiplication, almost beyond conception, of the means of spreading knowledge, these and hundreds more like these, so familiar now, are but the outcome of a search for truth, attainable only by man in a reverent study of nature; and the reason is obvious, for while in politics, and in business too often, men attempt to obscure a difficult question, those who "devote their lives to scientific investigations, cultivate a love of truth, for its own sake, and, if anything be obscure, endeavor instinctively to clear it up."

Do not for a moment mistake me; when I claim so much for the study of nature, I am far from saying that this is all which is contributing to the well-being of society; the slightest consideration will show that there are two independent sources of knowledge, the internal and the external, or, as Whewell calls it, " the string and the pearls strung upon it," and in completed form not to be separated, and the domain of either is broad enough to satisfy the highest ambition. There are those who do not realize this; men often of high culture, and really honest intentions, who believe that the scientific man is one delighting to "spy, smirk, scoff, snap, snort, snivel, snarl and sneer," and who sincerely think that where fact and science come, there imagination must depart and "religion retire, like some ancient indigenous races before the well equipped invaders"; and that, while a few inaccessible mountain-peaks may remain in their possession, yet the rich and open country of every-day life, over which they once roamed in undisputed ownership, will be lost to them forever. And there are some who have no pleasure in being alone with nature. Forever wrapped up in self, unable to separate the great world of truth and beauty from conscious will, it is the same listless cry, What use to me; frittering life away like one who

> "Fingers idly some old Gordian knot,
> Unskilled to sunder, and too weak to cleave,
> And with much toil attains to half believe."

It is a real relief and comfort to turn from this distrust and doubtful faith, and find others who know that something can be done really true and human, and whose labors have already availed to lessen the sum of human suffering, and to bring in the happy sunlight to darkened homes and make nature's sweet music heard by "ears dull with pain." Yes, there is something vastly stronger and nobler than self which is working the tale of human civilization. It was formulated when Fenelon said: "I love my family better than myself, my country better than my family, and the human race better than my country." It is not an outcome from the agnostic's infinite, unknowable sub-stratum, of which we neither know or can conceive anything, nor of the positivist's sum total of humanity, with "the clothes of religion"; no, the mysteries of our being, as Lord Raleigh has said, "if penetrable at all by human intellect, require other weapons than those of calculation and experiment."

In constructing, then, the fabric of human society and placing it on a sure foundation, in providing for the exigencies of the future, where may we seek for a balance-wheel, a controlling power; and how may we hope to solve the mysteries of social causation? The wisdom drawn from the study of history has failed to give the requisite knowledge in politics, and classical culture has proved inefficient; the experience obtained from the halls of Justice—the lessons of the forum, of the exchange, and of the workshop, do not much help us; and all sober, thinking men concede that neither speculative theology or positive philosophy is adequate to meet the wants of society, or to furnish a remedy for the evils arising from inconsiderate, hasty, or unwise legislation; evils which are, however, constantly staring us in the face, and which must be met.

In discussing a remedy for such deplorable results as depreciation in the value of labor, not always apparent, but nevertheless real, the growth of pauperism, and the "growing despotism of office," ills that have been prolonged or strengthened by the very means proposed, and often honestly advocated, to ameliorate or do away with them, every one acknowledges the failure of sumptuary laws and sanitary regulations, whose authors and advocates, acting in good faith, have found, when too late, that they have put in motion forces which, if they had not been controlled by a more powerful but unsuspected agency, would have effected far more of evil than of good. Under the influence of a controlling power, which is, unseen and unsuspected, permeating and remoulding society, we are already coming to recognize the futility of mere legislative attempts to regulate the hours and amount of labor, and, that universal taxation, for the support of so-called public charities (really support of pauperism), nay, I may even include, in part at least, for the education of the community, in view of the demands now made for a higher education to be supported by taxation, is wrong. I say, that we are beginning to recognize that these, however commendable in theory, as also the absorption by government of not simply the postal system, but, as with mistaken zeal many are now desiring, ultimately that of telegraphy and of railroads, as already of canals and of banking, and so forming a political engine, "controlling, without mercy, the rights and liberties of individuals,"—I say, we are beginning to recognize that these must end as miserable failures; and that the evils that are now more or less upon us, and have been increasing, like all noxious things, not only without cultivation, but despite honest endeavors to eradicate them, must be met and controlled by some more efficient power.

Now, we may call this power religion, education, "culture and sweetness," or even science; under whatever name, its office is, to exalt the search for truth for the love of truth; to oppose subtilty and artifice; to promote a love of the beautiful, and so of literature and art; and above all, that belief and trust, which is the very essence of religion. This is the power which will make a community of nations and beget wise reciprocal intercourse, as already foreshadowed in an international congress and the advances towards the adoption of universal time and prime meridian, and unification of weights and measures. It has been asked: "What better remedy for social evils can be desired than the collective wisdom of the people, embodied in the choice by the people of their leaders?" Granting that this choice has been wisely made, too often, as we all know, not the case, what has been the result? Let Communism and Nihilism reply.

I dare say that we have, many of us, been at some time in the presence of a mighty engine, and have noticed, almost with awe, upon the motions of how small and apparently insignificant a part of the ponderous machinery, the success and perfect working of the whole has depended; or, even if we have not seen this, we have instinctively realized its presence. Happily for society, there is such a regulator, though the mass of the busy world do not recognize it, silently and ceaselessly working to right the wrong, and to keep all right. The little needle, that quivers day and night, in sunshine and in storm, ever faithfully guiding the richly freighted ship over the trackless ocean, is not more true. A careless, pleasure-seeking world may look upon it as only a bit of useless steel for boys to play with, and think as lightly of it as of the rusty nail that the boy is raising with it; and yet, the study of the mysterious forces which cause the nail to cling, has not only opened up in the past, but will yet more and more in the future, possibilities of advance that set at naught the machinations of demagogues, and the ambitions of desperate men, guiding the ship of state in the right path, though these, as the storms and cyclones for many a noble vessel on the ocean, may sometimes swerve it hither and yon; and so it has come about that civilization is doubtless advancing, with no uncertain tread.

Looking merely at results, one is astonished at the substantial progress; and, best of all, it is a progress which, unlike that of past ages, cannot revert. Here history cannot repeat itself, the evolution is ever from lower to higher, in the order confirmed when the divine Architect looked upon his work and pronounced it, in his sight, very good, In the history of the past, civilized nations have indeed relapsed into a more barbarous condition, or at least not advanced; but a civilization based on scientific facts, and guided and controlled by scientific truths, has no such possibility.

It is entirely beyond my ability to show to you as clearly as I could wish, how a regulating power, the unconscious influence of scientific studies, is directing and reconstructing political machinery, and is, so far, the remedy for social evils; for, while we must allow that such remedy actually exists, you will agree with me that it is not to be found in greater purity in official life,—such an assertion you would meet with an incredulous smile; nor yet is it in wise, even if it be honest, legislation,—such an idea does not mislead anyone; certainly not in the true adjustment between labor and capital, at last happily accomplished,—strikes and the long categories of strife, bloodshed and misery, form the background of this picture. It is not, then, by these, or by any combination of these, that we have a remedy for the antagonisms which exist, and must exist, and which, paradoxical as it seems, when controlled, are beneficial. Nay, our trustworthy hopes for a glorious future are based not on speculative, but on scientific grounds.

If there is any being to be pitied, it is the pessimist, and, closely allied, the agnostic; the one sees nothing but evil, and that continually; the other sees nothing but a grave, in which he buries everything, " and vents his disappointment and resentment on the cold mountains and distant stars, which have no sympathy for him." The true student of nature, on the other hand, as I trust we all claim to be, sees before him a world of promise, of beauty and of love; his hopes for the future are based, not on metaphysical conceptions, nor solely on faith, but on a substantial, real existence, the evidence of which is drawn from, and founded in, scientific investigations of nature, applied directly,—not far off in the dreamland of philosophy, but at our very doors, in our humblest homes, every day, every moment, assuaging the ills of humanity, nay, making humanity possible and lifting us one and all to the clear light of truth,—giving strength to the weary, hope to the downtrodden and health of body and mind to all.

The electric cables and telegraph wires which are to-day uniting as one, far distant communities, are results neither of speculative philosophy, nor of legislative enactments; they are but a part of the many blessings that science has given to help redeem the world, and which are doing it. The great truths which have made such gifts and thousands of other like gifts possible, all working to the same end, have not been brought to light by studies fostered by mistaken ideas of redressing human wrongs, by relieving deserved human suffering and so setting at naught the decree of the Creator by softening or blotting out the penalty he has attached to sin; nor from studies for love of gain, but for love of truth; and this searching for truth is, I take for granted, the aim of every worker belonging to our Association.

If we accept the Darwinian principle, as I suppose the most of us do, and admit that the development is the natural outcome of the surroundings, we shall find, if we look at it deeply, not superficially, it is the expression not only of what is, but what is to be; a law of morals; and the physical and social factors of man's constitution will be found so closely interwoven that we cannot separate them. True, the fittest, in the natural Darwinian sense, in our yet developing condition, and the fittest in the moral sense, are not always the same now, but we have abundant reason for the hope that this highest condition is one towards which mankind is steadily approaching. The advances already made are great and full of interest; and the pursuit of those studies conducing to physical, mental and moral development alike, is of highest promise. To the truly scientific worker, with this development in view, "no subject is too vast for his research, no object too minute to be unworthy his patient study." Thanks, then, to the resistless, though unconscious, influences of science studies, moving the world to-day, not only is the pulpit sounding a more healthy tone, but the movement has reached the forum and the workshop.

To-day, to be saintly is not to fly from human contact to some hermit's cell in the wilderness, nor is it to bury one's self in nunnery or monastery. There was a period in the history of the world when this was saintly. In our own time we have known other saints, who, driven by their environment, have entered boldly into the dens of vice, and gone down into the dungeons of despair, bearing not "theoretical fantasies which in the dying leave fallen man yet lower," but with the ever-living truths and possibilities of a regenerated nature working out the only lasting reformation; we have known such, doing their work faithfully, responding, like the tuned string to its chord, in entire harmony with natural law, for, by this law, as Herbert Spencer has put it, "whatever amount of power an organism expends in any shape, is the correlate and equivalent of a power that was taken into it from without;" and so, while to them it was all, and truly, but from a love of Him who first loved them, it was, in a yet more satisfactory way, the confirmation of his declaration, "Without Me ye can do nothing." The great body of faithful students who have interpreted and handed down to the successive generations the eternal truths written in the works of creation and conformed their lives thereto, these are the men who have borne the heat and burden of the day, and they are the last to murmur when those who have been all the time standing idle in the market-place come in and labor but for one hour, and receive the same penny.

It is far from my intention in anything I may now say to urge greater prominence to the study of science or of nature in our schools, or the presentation of science teachings more decidedly in the pulpit; all this is coming in due time and cannot be stayed; over zeal here, as everywhere, will but o'erleap the boundary and work mischief ; the improvement is coming and the true reformation, not so much by the conscious as the unconscious influence of truth. The harvest truly is great and the laborers few, but in the future, as in the past, minorities will continue to rule the world, and microscopists, of all students of nature, can most readily comprehend the influence of minute forces. While no one will be so rash as to declare that the controlling influences which are so powerful to-day have been sought for and put to use as remedial agents, yet one, not on the other hand, can deny that they have originated from a study of nature for the love of truth, and, conjoined with purely intellectual concepts, have become the principles of social life—the ideas of the people and mainsprings of civilization.

A devout student of nature, like Oersted, for example, when he discovered the influence of electric currents upon the magnetic needle, and felt that joy which only a reverent student of nature can feel who presents to the world a real fact, little foreseeing its possibilities,—I say, such a student, has been of far more use to the world than the whole category of noisy demagogues, who have strutted their brief existence on the stage of history, the envy and the admiration of their fellows, but whose careless or mischievous work he has undermined and is to-day undermining; for the whole system of telegraphy, the telephone, and of electric lighting and plating, and—where shall it end?—of widening and regenerating benefits, can be traced back to the discovery made by this simple-minded and devout (for he was a Christian man) student at Copenhagen. I need take but this single instance; it will serve to illustrate what I mean by unconscious influence. A few years ago, when Ohms, and Webers, and Amperes, were unknown, when gas-lights gleamed red and smoky in dark lanes, and cunning men, outstripping the slow mail, put their hands into the pockets of country farmers and merchants (it was a laudable business enterprise—possessing knowledge that was not accessible to these), when criminals were safe, easily eluding tardy justice, when poor but honest homes were denied all the refining influences of art or education, and the silver and the gold came only as heirlooms to the favored class,—in those "good old days" that we are sometimes fond of speaking of, and which have, indeed, a sort of glamour about them in the distance,—in those days when men were old and worn out long before the threescore-and-ten, and grandmothers wrinkled, worn out and toothless at a yet earlier age,—in those "good old days" when the divine right of the king was the master-key of the forum, and when calomel and the scalpel reigned supreme in medical halls, and when theology, alas that it was so, was vainly attempting a tilt with science, when geologists were akin to infidels, and farmers planted and reaped with the waxing and waning of the moon, were people then really more happy? was society then really better? was there greater individual liberty, or better and truer civilization?

We sometimes, nowadays, talk about the "shocking increase of crime," and of the thousands of laborers thrown out of employment, of the hundred thousand communists who, to-day, in these United State, have a "boundless animosity against all existing social institutions," as indicating that we have indeed fallen upon evil times, and that everything is "going to the bad." On the surface it is a frightful picture, but could we as clearly unfold, as science is now doing through telegraph and press, the sum total of good and evil in those "good old days" as compared with that of the present, the balance would be found far on the side of the present, and indeed it needs no balance-sheet, the general conquest of good over evil is felt and confessed by every one, without necessity of argument.

In looking back, hardly beyond the memory of some of us, we see, indeed, a pretty picture, and this sitting beside a huge fire-place and the blazing Yule-log, is yet pretty,—on the wall. The return somewhat to the cheerful hearth which is coming about, is not altogether an æsthetic drift—nay rather, microscopical science is enforcing it from studies of the impurities that beset us in our homes, and is restoring at the same time the best means of ventilation and of social reunion. It is science that is compelling this, not fashion. Happily, in this case, fashion, and more and more may it be true, is following closely in the steps of science.

To look at it from another point of view, we would scarcely give up our railroads, our telephones, our presses, and our steam furnaces, much less our table conveniences and our luxuries, now necessities, all gifts of science studies, to return to the "good old times." Man is, after all, a "beef-eating animal"; politicians, and sometimes scientists, as doubtless we may show by and by, are reached through the stomach, and when we survey the long rows of ranges, the multitudinous kitchen paraphernalia and house conveniences, we involuntarily exclaim, "How did our grandmothers live?" Live! they did not live; they became prematurely old, their lives were spent in toil and weaving "linsey-woolsey,"—and yet, they looked back upon their own grandmothers in much the same way, and wondered how they *did* live. This much we may say, they were true to their times, their surroundings, which is the secret of happiness and progress. The same silent forces which are influencing us were moving then, dimly and slowly, for them; the work to be done was then, as now, an advancing work, and nobly, though not always understandingly, was it done. Already, in the generation past, the silent influences of the studies of men like Newton, Watt, Oersted and Davy in general physics, and Linnæus and Swammerdam and Leuwenhoek in natural history, were beginning to be felt; and the quiet, controlling forces, set at work by such men, became, in time, the ideas of the people, correcting the mistakes and bad counsels of leaders, just as they are doing to-day. They were then but as the little streamlets, traversing far off, down the mossy hills, flashing God's sunlight in sparkling drops, falling from frond to frond of ferns, or lying in some exquisite chalice of nature's mould; to-day, those streamlets have united, and, as lively brooks, they water pleasant fields, or as larger rivers, bear down the products of the soil to distant havens, and make one community of widely-separated peoples. To-day, we stand upon the borders of a mighty ocean; the ceaseless ebb and flow, the rhythm of the tides, goes on, as from creation, but the white sails now flecking the far-off horizon are as doves' wings; and to-morrow, that ship of which we have dreamed and which we have watched for, prayed for so long, will surely come in, and will bring to us more than we have dreamed of: gold of Arabia, spices of India, best of all, good tidings from our brothers in other lands, "Peace on earth, good will to men"—that Christmas song, better than the Yule-log of the "good old days," now realized.

Let us believe that we are here to make the world better; not content to remain inactive because there are depths that lie beyond the region of our will and choice. Every gathering like the present one is leaving its influence for the better. True, we do not come here to study out a remedy for social evils, however these may be affected by our studies and our mutual intercourse; this we leave to the keeping of the beneficent Father of us all. We come here to work, searching for truth in the love of truth, for the love of the beautiful; and if we are sincere in this we need have no fear that the influence of our lives and works will be lost. We sometimes hear about "conflicts between religion and science"; such antagonism is more apparent than real. Under the influence of the very studies which form the subject of our own investigations as microscopists, theology is drifting in the right direction and has already learned, as Carlyle says, "that the public highways are not to be occupied by people demonstrating that motion is impossible," and that religion has nothing to fear, but everything to gain, from an alliance with science. Lowell has well said:

> "Science was Faith once; Faith were Science now,
> Would she but lay her bows and arrows by,
> And arm her with the weapons of the time.
> Nothing that keeps thought out is safe from thought;
> For there's no virgin-fort but self-respect,
> And Truth defensive hath lost hold on God."

It is but a few years to look back, and we find good men no doubt, and honest, fearful and distrustful when geology began to assert her claims as a science. Forgetting that the older science of astronomy had already experienced such a reception, and already confessing that "the heavens declare the glory of God," they were afraid of "the round world that He had made so sure." While, happily now, geology and religion go hand in hand, yet, still timid and over cautious—nay, at first aghast—pious men see heresy in evolution, and atheism in the "survival of the fittest." The leaven is working, however; they have read, but never before knew its depth of meaning: "He hath given them a law which shall not be broken." And I cannot refrain here from bearing testimony to the position of many of the ablest dignitaries of the grand old Church of the English Reformers, in regard to this question; and I need but refer to the distinguished President of the Royal Microscopical Society, who made us such a pleasant visit at Rochester last year, bearing greetings from our brethren of the Empire, and whose hard common-sense, ready wit, and kind actions, demonstrated how little was the antagonism between religion and science.

Not theology alone, medicine, from a different standpoint, and even less defensible, was found but a few years ago opposing science. The drift has overtaken here, and is in the right direction now. I can remember, and others here present can remember, when the physician who had recourse to the microscope to aid diagnosis was looked upon as a crank, and treated as an empiric not altogether harmless. Soon this came to be done on the sly; then, one by one, the medical schools thought there "might be something in it," and lastly began to teach and require it, and to-day no physician can afford to dispense with the microscope; and though there be, yet, a few of our older practitioners who give a wise shrug when some of the younger brethren profess through its use to gain a deeper insight into the nature of disease—its cause and remedy,—even these are unconsciously drifting and practising in accordance with the new teachings, to the great benefit of suffering humanity.

I have been led away in the opening of this vast subject before me, the unconscious influence of natural science studies, from considering it in its more particular aspect, as affected by microscopical studies, and which appeals more directly to us; and here let me allude to the great science of biology, which may be said to owe its existence to the microscope, and the study of which as now conducted in our laboratories is of the last importance to the world. Here we find ourselves on the borderland of being, and, in dealing with the almost inconceivably minute organisms, "the beginnings of life," we demand the highest scientific skill in the construction of our instruments and the utmost degree of patience and intelligence in their use. In regard to the former, I need not attempt to say anything; you will have, in our working sessions and at our annual *soirée*, abundant opportunity to judge for yourselves; in regard to the latter, the value of our investigations, I trust that our present meeting will not fall behind that of previous years—nay, will show decided advance. So far as the instruments of research are concerned, the biologist is already in possession of almost all his wildest dreams could ask, and already the work accomplished in the study of microbes, the septic organisms, the monads and the bacteria, which swarm in countless millions around and in us, has effected almost a revolution in medical science; and the silent influence of biological studies, powerful as it has been, will yet continue to be felt more and more decidedly, with "infinite possibilities not of man only, but of man and beasts,"—yes, every living thing.

Tempting as it is to try and unfold somewhat the line of progress in biological sciences during the past few years, I find myself quite inadequate to the task, nor, indeed, for my present purposes, is it necessary; for, interesting as it might be to the members of our Association, it would require some one far more familiar with the subject than myself, to make it so for a popular audience. This much I am sure of (and here is where the influence of these studies is moving the masses, and contributing to work out a more perfect civilization), anything that can claim, with assured certainty, to arrest the fearful progress of contagious diseases, of plagues upon our cattle, and blights upon our crops,—anything that can give to suffering humanity a new hold upon life, with better food, with better air, a sounder mind and better developed body, will always find in a popular audience ready and sympathetic hearers.

Now, all this is what biological studies claim to have already accomplished. True, these studies are yet but in their infancy, but there is a promise of unfolding of so much, that it would fail the pen of a readier writer than myself to depict it, and yet be quite within the bounds of truth. Vast problems lie before us yet unsolved, but which will one day be solved. The study of the swarming myriads of bacteria and micrococci, the harmless and the deadly, their relations, the possibilities of change, the effects of culture and successive generations, as affecting the septic and pathogenetic microbes, the true meaning and value of inoculation, all these investigations present immense difficulties, which it would be almost impossible to exaggerate. If we take but a single example, the bacteria of Davaine's septicæmia,—these are so minute that 250,000,000,000 would only occupy a space about the size of an ordinary drop; now, the 100,000,000th part of such a drop has been proved to be fatally infective. Minute as these microbes are, their morphology is approximately within our reach, and the questions, as to how far they are mutable and, if so, under what conditions, and whether functional changes are induced as readily as, or more readily than, morphological, are of the largest moment.

Meanwhile, as to practical results, and that is what most concerns us here, as the indirect or unconscious effects of biological studies, themselves largely due to or encouraged by associations like that which gathers us here at present, every one will bear testimony to the greatly improved methods of medical practice, of ventilation and sewerage,—indeed, one of the most important functions of microbes is the disintegration of sewage compounds, and their nitrifying action, a process by which nitrogenous substances are made soluble in the soil, and so, available for vegetable growth. When we consider that the germs of these organisms are everywhere present, "in the air, in water, on the surface of every kind of matter, in the interior of bodies living and non-living, within the blood and the substances of the tissues, in all animals and in all plants, at all temperatures, nearly in all parts of the world," and that their presence or absence will, no doubt, yet prove to be one of the most marked characteristics of climate, so that the effect of particular climates or localities on particular diseases shall be scientifically demonstrated,—I say, when we consider these things, why should not scientific men have "microbes on the brain," as has been said in jest? And why, to change somewhat the poet's line, may we not say: "Microbe, the proper study of mankind"? No doubt, the alleged finding of the potent principle of normal and abnormal phenomena in these infinitesimal specks of life may sometimes justify a sneer; but, on the whole, as a witty writer has said, "these discoveries will be scrutinized and tested by the sceptical or critical, and it will be a lucky microbe that comes out of the ordeal with satisfactory credentials; it may well plume itself on its assured position in the new doctrine of infinitesimals, and flaunt its ten-millionth of a millimetre of tail contemptuously in the face of the unbeliever."

In the important matter of sewage, to which I have alluded, the beneficial results to the community, arising from scientific microscopical examinations, cannot be overestimated. Thanks to these studies, undertaken many times, not with this direct object in view but assured that any new scientific fact has incalculable value, not only the influence of the micrococcus in converting noxious matter into innocuous chemical compounds is well understood, but the conditions most favorable for effecting this with rapidity and certainty; conditions which, if not attended to, might render the sewage of a whole town incapable of purification. Not only the effective disposition of sewage with certainty, but the elaboration of it into material food for plants, and ultimately again for man, is something of such vital importance to the welfare of the community, something which, when accomplished, is such a direct element of civilization, that I feel that I am quite warranted in alluding to it here, as one of the unconscious benefits conferred upon society by science studies; studies of nature that go far, very far indeed, to counteract the evils that arise from false systems of education or misdirected legislation.

It is the great and crowning glory of biological studies, that the student is investigating a world of life; matter, as it comes under his cognizance, is not dead, but fresh and living, and as it is through millions of infinitesimal living agencies that healthy work is being performed, it may yet appear that these minute organisms are the promoters of what we call "normal action," keeping the body sound despite violations of nature's laws, acting with never-ceasing vigilance in every cavity and pore, and at each resting-spell recovering the lost ground, disposing of the body sewage; and thus man, and society as well, through their agency, is coming out of the struggle of "survival of the fittest," yet better, and advancing to higher perfection and development. No field of microscopical research requires better optical appliances, none more care and patience, and certainly none is more worthy the attention of microscopists.

There is another and very important application of the microscope in scientific investigation to which I may allude, though the results here are not as immediately apparent as in biological investigations, and yet who shall venture to name a limit or bound to the beneficial effect which must forever go on widening and strengthening with each newly-discovered fact? I allude to the application of the microscope to geology—not simply to a part, as in mineralogy, but in a more comprehensive sense. It is a branch of science which has already many enthusiastic and capable workers, and training in a petrological laboratory will soon become as necessary and important a part of a geologist's education as in a biological one already is to the modern physician.

Of the benefits conferred upon society by geological studies, I need scarcely attempt to name them. Marvelous, indeed, has been the growth from wilderness to great cities. Railroads, the telegraph and the tide of civilization, have followed the sound of the hammer and chisel of the geologist, and to-day our great country is one busy field of workers; the coal, the iron, the petroleum, the silver and the gold, sinews of civilization, under the guidance of science, are being wrested from the dark caverns and gloomy mountains, by the ceaseless throng coming from the overstrained old world, and preparing the way for the new civilization. The application of the microscope to geology promises to be of more value than it has already proved to be in mineralogy, and important as the latter is, we must recognize it as but an introduction; we may hope, ere long, to discern clearly the structural and chemical changes, the alterations of sedimentary rocks, in contact with igneous, under varying degrees of pressure and heat, the all-important and widespread effects of metamorphism, as clearly as though we had, during the geological ages, seen these processes actually going on; and we may learn that catastrophes, cataclysms, and all the varied effects of tension and pressure, are but inevitable sequences of laws whose operation may be foreseen.

What a picture is presented to us in the natural world of what we have seen and still must see in the moral and political world. The glowing fires beneath the vine-clad hills go on with surely increasing strain, while the world of beauty above them, under blue skies, fanned with balmy zephyrs, dreams of paradise. To-day,

> " Far, vague and dim,
> The mountains swim;
> While on Vesuvius' misty brim,
> With outstretched hands,
> The gray smoke stands,
> O'erlooking the volcanic lands."

To-morrow, when the last grain shall be put on to the poised balance, the old shall pass away, and be replaced by a more enduring new. So, in the political world, the volcanic fires of the commune, the metamorphisms of revolution, have, like the great geological changes for the physical world, been perfecting the world of social existence; and, yet, the whole is but the result of the working of long-continued, minute and, in themselves, unrecognized forces. The application of the microscope to the study of rocks, shows to us in the inorganic world that same unstable equilibrium which is the characteristic of life; for, imbedded in the crystal, in cavities so minute that a thousand to ten thousand millions would occupy only a cubic inch, are imprisoned liquids " which must have been formed under a pressure sufficiently great to reduce not only steam but volatile hydro-carbons and even gaseous carbonic acid to the liquid condition," and which respond in wonderful gyrations to the most infinitesimal changes of temperature and pressure. What a vast field of research and scientific study is here opened before us. We may almost roll back the æons and, face to face, contemplate the operations of those forces that from the beginning have built up not only our own globe, but the whole grand system of which it is so small a part, and comprehend them as though we had been present at the beginning.

But I must not be tempted to digress too far from my theme, the unconscious influence of science studies in moulding the every-day life of a community. We sometimes talk about fashion and the influence of fashion, especially upon our wives and daughters. We hear it said : " Make it unfashionable to drink or to gamble, and our young men would stay away from the saloons and the faro-table, and our daughters from the heated ballrooms and theaters; but what is the influence of ephemeral fashion, compared with that of the teachings of science, felt, seen and heard, every moment of our lives, in the myriads of ways in which we experience them ? Not a hod-carrier climbs wearily up the ladder with his load of mortar or bricks, but is all the better for the electric light, the telegraph, the railroad and the press; better sanitary conditions and better medical treatment make his life bearable, and he has, however slight, some ideas which are helping to elevate him out of the ditch in which his fathers spent their lives, and his children, through the simple avenue of the senses, if not from education, are walking upon a higher plane. As each individual cell of a body contributes its share to the formation, though not controlling it, but in obedience to the sum total of the forces, so each conscious will or purpose is contributing to shape the course of history and destiny of nations, and the minute forces which direct and control here, though not recognized, are nevertheless of the last importance. We have but the feeblest conceptions of "the vast unknown territory that lies back of conscious will and is really the controlling power of life; out of it things arise and define themselves to our consciousness, and rule our career. Here the influence of environment works; here the elements of race and family; here the time spirit moulds us, and we know it not; here nature, or fate as we sometimes call it, rules us, and makes us what we are. In every people or nation, stretches this deep unsuspected background; here the deep processes go on and here the destiny of the race or nation lies. In this soil the new ideas are sown; the new man, the despised leader, plants his seed here, and if they be vital they thrive and in due time emerge and become the conscious possession of the community."

Looking, then, at the actual condition of society, not as it appears to a superficial observer, but in view of the entire surroundings, calmly, and in the best sense of the word philosophically, we are yet more and more firmly convinced of the Darwinian principle, potent in the intellectual and moral world, as in the natural. "Whatsoever things are good, whatsoever things are lovely," will, in the future, as shown in the history of the past, commend themselves, and become the powerful factors of a better civilization, and the contrast of the world of to-day with that of yesterday is full of assurance of this. We need not, then, trouble ourselves with gloomy outlooks for the future; dark forebodings that where science comes, there religion, and there poetry and art must disappear, and closed forever be the

> "Charmed magic casements opening on the foam
> Of perilous seas, in faery lands forlorn."

While, as scientific students, we must needs be specialists, since so vast is the field open to us and so rapidly extending are its dimensions that the demands made upon us confine us to very narrow fields of labor, we should only be so for the laboring hours. If we turn the microscope the other way, changing but a little, we have a telescope; and a far-off world, of which, as microscopists, we had no conception, lies spread out with its unfathomable depths. The methods of science and those of theology are as diverse as are the microscope and the telescope, and though there is one underlying principle for both, they can never exactly come together without ceasing to be, the one a microscope, the other a telescope,—the one science, the other theology. Nor is it best for us that they should, or that antagonisms should cease: science is in danger from specialism, and the antagonism of classical studies, metaphysics, theology and art culture, are real necessities for the development of a well-balanced civilization. While nature in itself is not evil but good, and while the study of nature gives boundless scope for the intellectual powers of man, and opens to his imagination boundless visions of beauty, as well as unlimited stores of facts, let us be careful to award to the other means of intellectual and moral culture the due meed of praise. Our statesmen, our theologians, our physicians, and, far more, our artisans and laborers, will ever make the mass of any community; we cannot ignore their lives and their labors; happy indeed, if still, with the advancing civilization, the influence of science be found, like the balance-wheel of the chronometer, though apparently but a small part of the beautiful combination of well-finished wheels and springs, the important part, controlling the motions of the whole with the regularity, almost, of that majestic motion of the heavens with which, always, we must compare it.

And now, in closing, may I be permitted a personal reminiscence? Twenty years, almost, are passed, but the scene is as freshly before me as though it occurred but yesterday. I stand upon the cliffs at Alderney; far off, on the horizon, I catch a glimpse of France, reflecting back the warm glow of a closing summer's day. Away below, I hear the booming, surging swash of the incoming waves of the yet low tide; and now, I am down the steep descent, and clambering over the wet and slippery rocks, rich with piles of seaweeds, full of microscopic life; and as I sit, anon, in one of the dark caverns hammered out in the rocks by ocean tides and currents during a geological age, and muse upon the mysteries of life, so wonderful in the minute algæ that I have gathered, I feel the influence of the environment, and am conscious of its power upon the better half of my own being; and as the day declines, and in the clear blue eastern sky appears a pale, not yet completed disc, I see with mental vision, following in under this, the great tidal wave, and know that soon these limp, but still wet, mosses will float joyously, and spread out their eager fronds in the welcome bath; and I realize that "He hath given them a law which shall not be broken"; and with firmer trust, but not self-satisfied,—with better resolutions, but not less faith, the exquisite lines of Lowell come home to me, and assure me as they must you, that where Science comes, there Poetry will find her noblest use, there Faith her sublimest exercise.

"The drooping seaweed hears, in night abyssed,
  Far and more far the wave's receding shocks;
Nor doubts, for all the darkness and the mist,
  That the pale shepherdess will keep her tryst,
And shoreward lead again her foam-fleeced flocks.

"And, though thy healing waters far withdraw,
  I, too, can wait, and feed on hope of Thee,
And of the dear recurrence of thy law;
Sure that the parting grace that morning saw,
  Abides the time to come in search of me."